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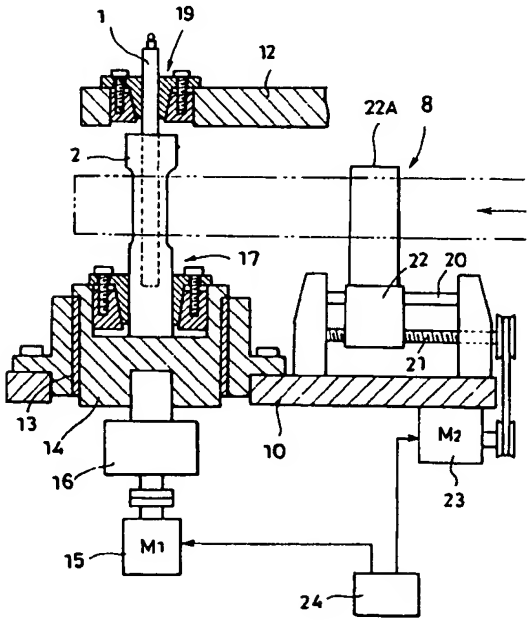
(54) Apparatus for bending a band-shaped work.

(57) An apparatus for bending a band-shaped work (W), the apparatus including a stationary cylinder (1) having at least a pair of slits (3) on diametrically opposite sides thereof, the slits (3) providing a passageway (3A) in which the work (W) is inserted through the slits (3), a rotary sleeve (2) accepting the stationary cylinder (1) with a gap interposed therebetween, the rotary sleeve (2) having a first opening (6) and a second opening (7) on diametrically opposite sides thereof, a first driving means (8) for feeding the work (W) passed through the passageway (3A) in the stationary cylinder (1) and the first (6) and second (7) openings of the rotary sleeve (2), and a second driving means (14, 15, 16) for rotating the rotary sleeve (2) by a predetermined amount while the movement of the work (W) is stopped so as to bend the work (W) between the stationary cylinder (1) and the rotary sleeve (2).

Fig. 2



EP 0 626 221 A1

The present invention relates to an apparatus for bending a band-shaped work such as a blade used for punching thin sheets of paper, cloth, leather, wood, and plastics to a desired shape. In this specification, the band-shaped work will be called "bandwork" for explanation convenience. The term "work" as used herein thus includes a strip-form or band-form tool or article, such as may be used, for example, in punching or perforating a piece of sheet material.

When a band-shaped blade is used to punch a sheet to a desired shape, it is mounted on a base, and fitted in a groove formed therein to the desired shape. In order to enable the band-shaped blade to fit in the groove, the blade should be previously bent at an obtuse angle, an acute angle or right angle depending upon the shapes of the groove and the radius of curvatures as shown in Figure 8 where the full line indicates a contour to be punched along and the dotted lines indicate foldable lines.

There are at least four known methods of bending a bandwork; first, by hand with a special tool; second, by means of three rollers (Figure 9A); third, by means of a pair of molds each having a required radius of curvature where the work held between the molds is punched under a single blow (Figure 9B); and fourth, by gradually bending the bandwork while it is fed through a pair of chips inch by inch (Figure 9C).

The last-mentioned method encounters two difficulties; one is that when a bandwork is bent at one spot at an obtuse angle, it often happens that the subsequent bending is difficult by bringing the already bent portion of the bandwork with the apparatus, and the other is that accumulated dimensional errors eventually fail to achieve the intended accuracy.

According to the present invention, there is provided an apparatus for bending a work such as a bandwork, the apparatus including a stationary cylinder having at least a pair of slits on diametrically opposite sides thereof, the slits providing a passageway in which the work is inserted through the slits, a rotary sleeve accepting the stationary cylinder with a gap interposed therebetween, the rotary sleeve having a first opening and a second opening on diametrically opposite sides thereof, a first driving means for feeding the work passed through the passageway in the stationary cylinder and the first and second openings of the rotary sleeve, and a second driving means for rotating the rotary sleeve by a predetermined amount while the movement of the work is stopped so as to bend the work between the stationary cylinder and the rotary sleeve.

The gap between the stationary cylinder and the rotary sleeve keeps the work safe from collision with the apparatus, and minimises a dimensional error possibly occurring at each spot, thereby achieving the dimensional accuracy.

The invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view exemplifying the principle underlying the present invention, particularly showing a main portion of the apparatus;

Figure 2 is a diagrammatic view showing the overall structure of the apparatus embodying the present invention;

Figure 3 is a diagrammatic cross-section showing the stationary cylinder and the rotary sleeve shown in Figure 2;

Figure 4 is a perspective view showing the stationary cylinder and the rotary sleeve in operation;

Figures 5(A), 5(B), and 5(C) are diagrammatic views showing the conditions of a bent bandwork in Phases (A), (B) and (C);

Figure 6 is a flowchart showing the sequence programmed under the present invention;

Figure 7 is a diagrammatic view showing a modification to the embodiment shown in Figure 1;

Figure 8 is a plan view showing a shape to be punched from a sheet; and

Figures 9(A), 9(B), and 9(C) are diagrammatic views showing known methods of bending a bandwork.

Referring to Figure 2, the exemplary apparatus includes a bed 10, an upper support 12 detachably fixed to the bed 10 by pillars (not shown), and a rotor 14 rotatably carried or mounted on the bed 10 by bearings 13. The rotor 14 is driven by a servomotor 15 through a speed reducer 16. A lower chuck 17 holds a rotary sleeve 2 which is secured to the top surface of the rotor 14, and an upper chuck 19 is held by the upper support 12. The upper chuck 19 holds a stationary cylinder 1 which is inserted in a rotary sleeve 2. The upper chuck 19 and the lower chuck 17 are coaxially aligned, and the stationary cylinder 1 is coaxially accepted or received in the rotary sleeve 2. The rotary sleeve 2 rotates when the rotor 14 is driven. The chucks 17 and 19 are designed to allow a substitute or different rotary sleeve and stationary cylinder to be used depending upon the thickness of the work.

Referring to Figures 1 to 4, the shank of the stationary cylinder 1 is provided with thick portions 1A and 1B and a slim portion interposed between the thick portions 1A and 1B. The slim portion has a pair of slits 3 on diametrically opposite sides thereof so as to provide a passageway 3A for allowing a work W to pass through in a straight manner. Different stationary cylinders have slits having different widths. Depending upon the thickness of the work W, they are selected, i.e. a cylinder with a slot of appropriate thickness is selected for a particular thickness of work W. The thick portions 1A and 1B are in sliding contact with the inside wall of the rotary sleeve 2. The rotary sleeve 2 is provided with axially lengthwise openings 6 and 7 on diametrically opposite sides thereof. The openings 6 and 7 and the slits 3 may be in alignment

in accordance with the rotation of the rotary sleeve 2. The opening 6 is located at the entrance through which the work W is inserted into the rotary sleeve 2 (and, therefore, the slits 3), and the opening 7 is located at the exit through which the work W exits out of the rotary sleeve as shown in Figure 1. The rotary sleeve 2 is provided with a relief 51 in the opening 7. Each slit 3 has edges 4 along the terminating corners of the side through which the work W exits, and the rotary sleeve 2 has edges 5 mating with the edges 4 of the slits 3. The edges 5 are movable in accordance with the motion of the rotary sleeve 2 in the directions indicated by reference K whereas the edges 4 are motionless. The amount of rotation of the rotary sleeve 2 is expressed in angular terms, and the rotational angle is accurately adjusted by controlling the servomotor 15. Reference "d" indicates a measure of the gap between the stationary cylinder 1 and the rotary sleeve 2 and its effect on the bending action.

In order to drive a work W inserted into the passageway 3A through the slits 3, there is provided a feeder unit 8 which includes a feed shaft 20 and a lead screw 21 which is kept parallel with the feed shaft 20, and a carriage 22 carried on the lead screw 21. The carriage 22 includes a clamp 22A for holding the work W with its blade upward. The lead screw 21 is driven by a second servomotor 23. The first and second servomotors 15 and 23 are controlled by a computer 24 under the program shown in Figure 6.

The work W is intermittently fed by the feeder unit 8, for example, 1 mm by 1 mm. While the work W is at rest, the rotary sleeve 2 is rotated so as to bend the work W by and between the edges 4 and 5. The amount of rotation of the rotary sleeve 2 depends upon the desired bending angle. The rotary sleeve 2 is returned and waits for the subsequent movement of the work W, and then resumes its rotation. The operation will be described in detail by reference to Figure 6.

Referring to Figures 5 and 6, the program of the computer 24 is prepared so as to meet the following aspects (A), (B) and (C):

Aspect (A): When the work W is bent at 90° with a small radius of curvature;

Aspect (B): When the work W is bent at acute angle A_1 with a radius of curvature R_1; and

Aspect (C): When the work W is bent at obtuse angle A_2 with a radius of curvature R_2.

A predetermined length of the work W is fed by the second servomotor 23 (Step 1). The rotary sleeve 2 is rotated by a predetermined amount by means of the first servomotor 15 (Step 2). The first servomotor 15 is reversely rotated (Step 3). The sequence is executed by repeating the three steps. When the carriage 22 reaches the forward dead point of its stroke, the clamps 22A are unfastened, and the carriage 22 is returned in a straight line to its original position. The feeding of the work W is resumed. For bending an obtuse or acute angle, a succession of intermittent feed actions may take place, with a bending action taking place between each feeding step.

Figure 7 shows a modified version of the reliefs in the rotary sleeve 2 and the stationary cylinder 1 in which another relief 41 is provided on each side of the stationary cylinder 1, and the reliefs 51 of the rotary sleeve 2 are made larger than those shown in Figure 1.

Claims

1. An apparatus for bending a band-shaped work (W), the apparatus comprising:

   a stationary cylinder (1) having at least a pair of slits (3) on diametrically opposite sides thereof, the slits (3) providing a passageway (3A) in which the work (W) is inserted through the slits (3);

   a rotary sleeve (2) accepting the stationary cylinder (1) with a gap interposed therebetween, the rotary sleeve (2) having a first opening (6) and a second opening (7) on diametrically opposite sides thereof;

   a first driving means (8) for feeding the work (W) passed through the passageway (3A) in the stationary cylinder (1) and the first (6) and second (7) openings of the rotary sleeve (2); and

   a second driving means (14, 15, 16) for rotating the rotary sleeve (2) by a predetermined amount while the movement of the work (W) is stopped so as to bend the work (W) between the stationary cylinder (1) and the rotary sleeve (2).

2. The apparatus according to Claim 1, further comprising a lower chuck (17) for holding various sizes of rotary sleeve (2) and an upper chuck (19) for holding various sizes of stationary cylinder (1).

Fig. 1

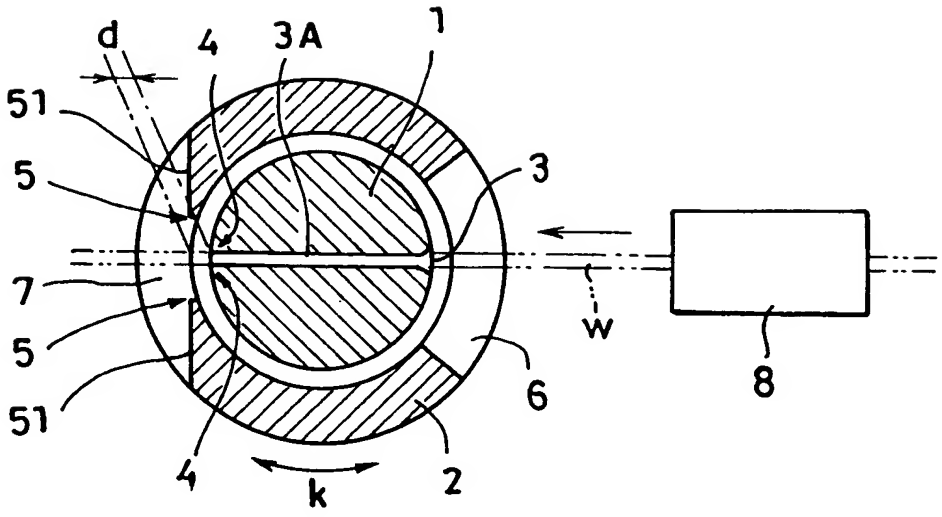


Fig. 2

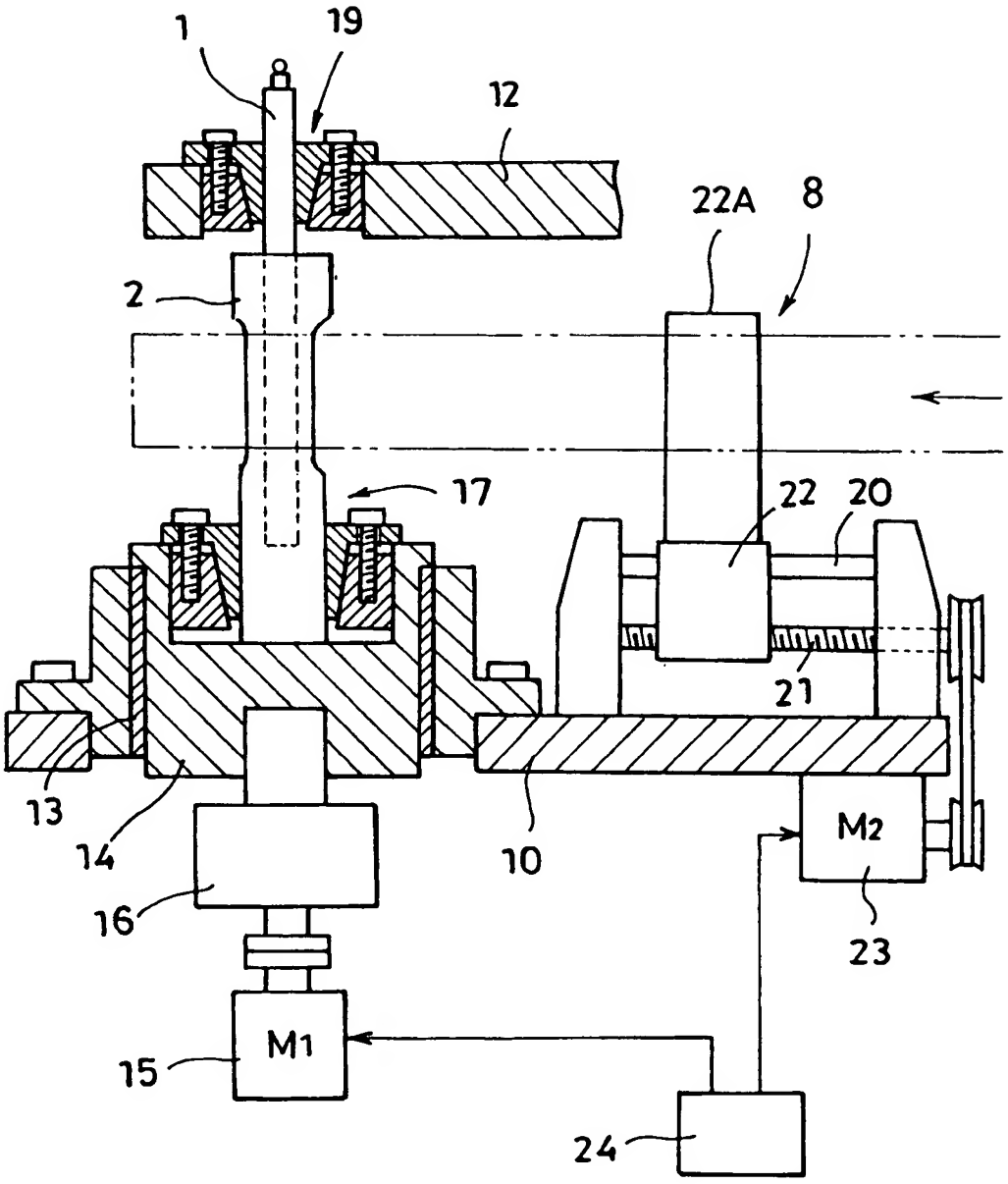


Fig. 3

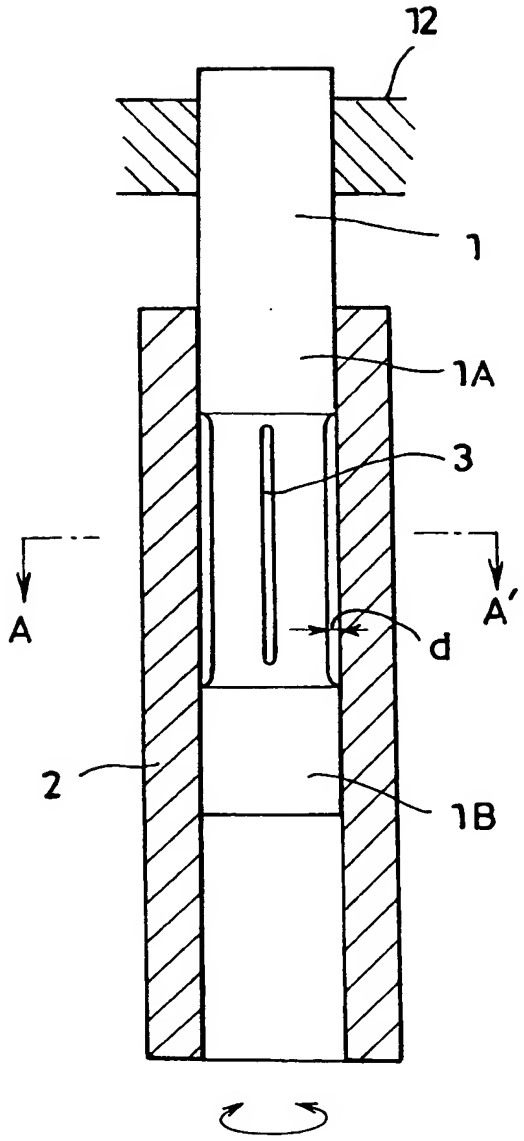


Fig. 4

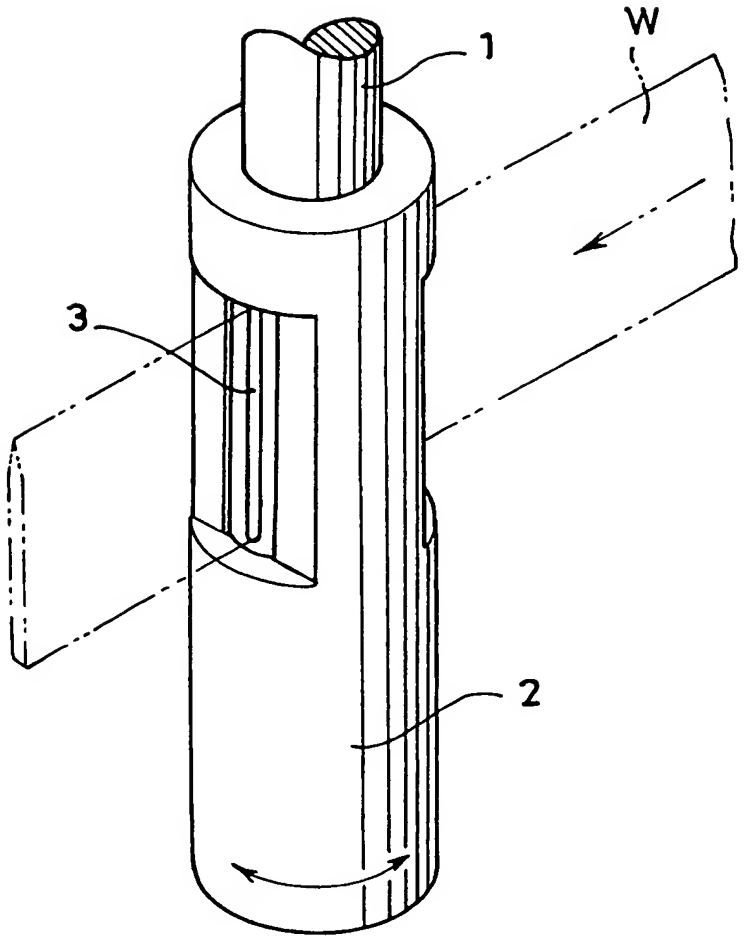


Fig. 5

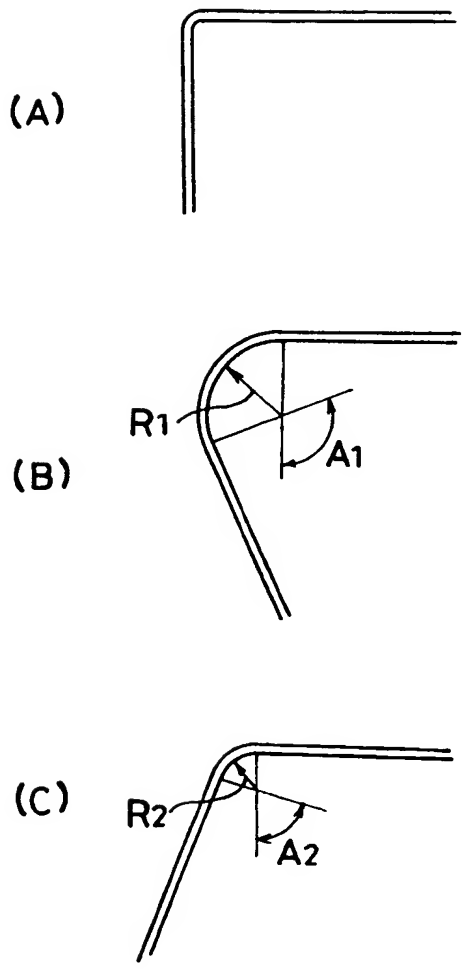


Fig. 6

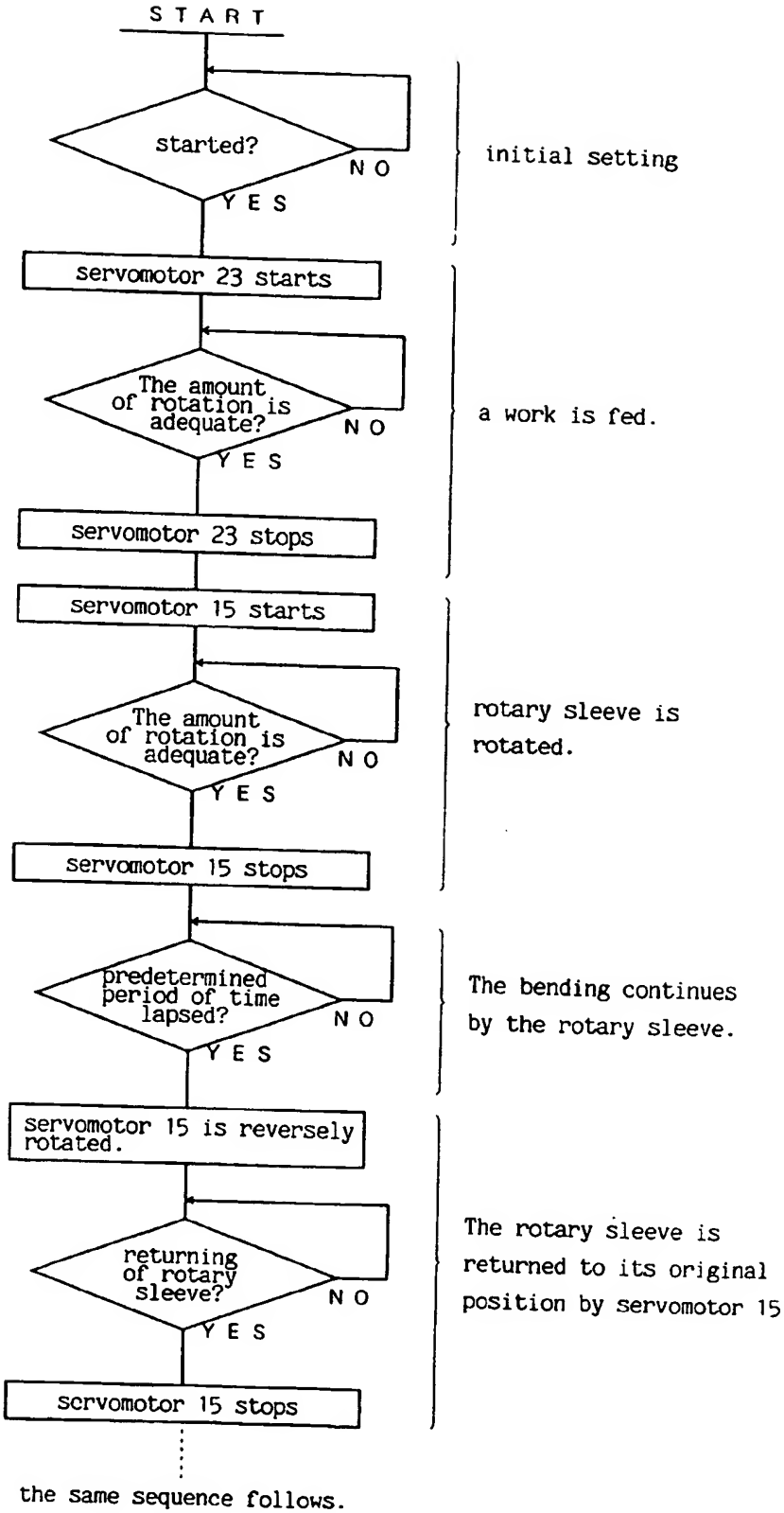


Fig. 7

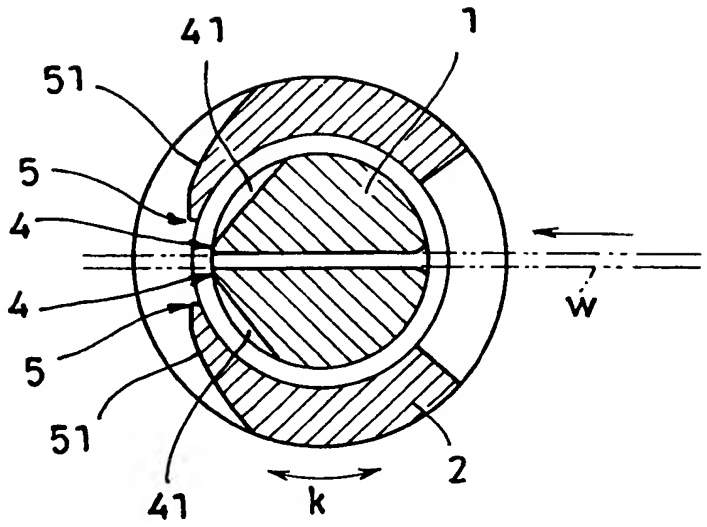


Fig. 8

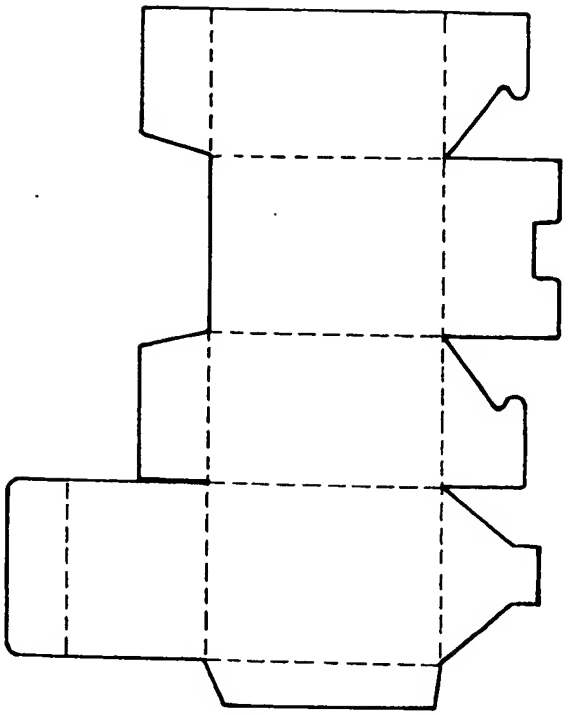
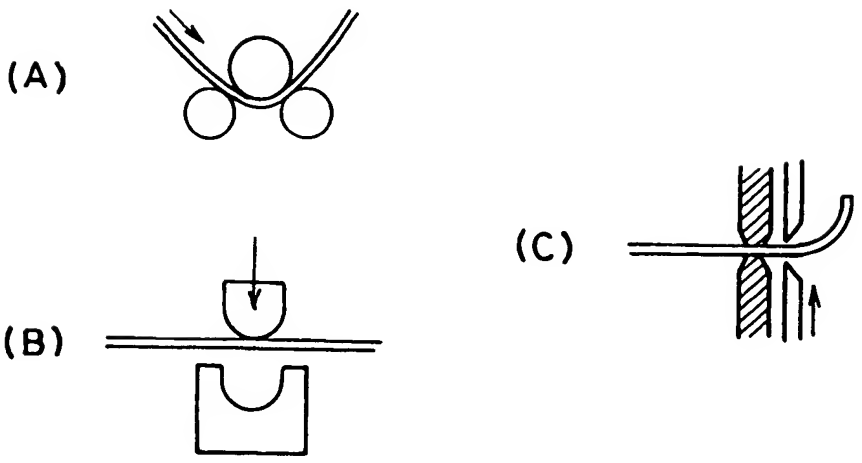


Fig. 9 (PRIOR ART)



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EUROPEAN SEARCH REPORT

Application Number
EP 94 65 0012

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	CH-A-592 481 (CAMPAGNA) * claims 1-3; figures 1,2 *	1	B21D7/022 B21D11/10 B21D53/64
A	DE-A-35 46 448 (ALPHA MASCHINENBAU) * claims 1-5; figures 1,2 *	1	
A	GB-A-2 116 086 (MANAGEMENT CONSULTANTS) * claims 1-4; figures 1-4 *	1	
A	EP-A-0 118 987 (BRITISH UNITED SHOE MACHINERY) * claims 1,4,6; figures 1,2 *	1	
A	EP-A-0 317 637 (MIZUKAWA) * claims 1,2; figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)
B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	22 July 1994	Schlaitz, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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